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APPLICATION NUMBER: ***10/125,862***
FILING DATE: ***April 19, 2002***

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Certifying Officer

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A

Vidas, Arrett & Steinkraus Utility Patent Application Transmittal	Atty. Docket No	H01.2-10395
	First Inventor	Ulrich Ising et al
	Title:	AN APPARATUS AND A METHOD FOR THE CHEMICAL MECHANICAL POLISHING OF THE SURFACE OF CIRCULAR FLAT WORKPIECES, IN PARTICULAR SEMI-CONDUCTOR WAFERS
	Express Mail Label No.	EV075164073US

Application Elements	Address To:	Commissioner for Patents Box Patent Application Washington, DC 20231

1. ☒	Fee Transmittal Form ☒ Check Included	Pages 2
2. ☒	Applicant claims small entity status	
3. ☒	Specification (including 0 pg cover sheet, 12 pg description, 5 pg claims and 1 pg abstract)	Pages 18
4. ☒	Drawings	Pages 6
5. ☒	Oath or Declaration	Pages 2
	a. ☐ Newly executed (original or copy)	
	b. ☐ Copy from a prior application (37 CFR 1.63(d) (for continuation/divisional with Box 19 completed)	
	i. ☐ Deletion of Inventor(s) – signed statement attached deleting inventors named in the prior application	Pages
6. ☒	Application Data Sheet	Pages 1
7. ☒	Assignment Papers (cover sheet & documents and check) ☐ Previously recorded on , Reel , Frames	Pages 3
8. ☒	Power of Attorney ☐ 37 C.F.R. 3.73(b) Statement (when there is an assignee)	Pages 1 Pages
9. ☐	English Translation Document	Pages
10. ☐	Information Disclosure Statement ☐ Copies of Citations (references)	Pages
11. ☐	Preliminary Amendment	Pages
12. ☒	Return Receipt Postcard	Pages 1
13. ☐	Certified Copy of Priority Document	Pages
14. ☐	Nonpublication Request	Pages
15. ☒	Constructive Petition	Pages 1
16. ☐	Limited Authorization	Pages
17. ☒	VAS Utility Patent Application Transmittal	Pages 1
18. ☐	Other	Pages

19. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment or in an Application Data Sheet

☐ Continuation ☐ Divisional ☐ Continuation-in-part Of prior application no.

Prior Application Information: Examiner Group Art Unit

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference.

20. TOTAL NUMBER OF PAGES 36

21. CORRESPONDENCE ADDRESS

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Name	Richard Arrett, Reg. No. 33,153	
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Modified PTO/SB/17 (11-00)

FEE TRANSMITTAL for FY 2001

Patent fees are subject to annual revision.

Complete if Known	
Application Number	-
Filing Date	Concurrently herewith
First Named Inventor	Ulrich Ising
Examiner Name	--
Group Art Unit	--
Attorney Docket No.	H01.2-10395

TOTAL AMOUNT OF PAYMENT ($)370.00

METHOD OF PAYMENT

1. ☒ The Commissioner is hereby authorized to charge indicated fees to:
Deposit Account Number 22-0350
Deposit Account Name Vidas, Arrett &Steinkraus

☒ Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17
☐ Applicant claims small entity status. See 37 CFR 1.27
☐ Credit any overpayments to Deposit Account No. 22-0350
Deposit Account Name: Vidas, Arrett & Steinkraus

2. ☒ **Payment Enclosed:**

☒ Check ☐ Credit Card ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	740	201	370	Utility filing fee	
106	330	206	165	Design filing fee	
107	510	207	255	Plant filing fee	
108	740	208	370	Reissue filing fee	
114	160	214	80	Provisional filing fee	

SUBTOTAL (1) $

2. EXTRA CLAIM FEES

	Extra Claims	Fee from below	Fee Paid
Total Claims	15-20** =	X ---- =	
Independent Claims	2-3** =	X ---- =	
Multiple Dependent		---- =	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	84	202	42	Independent claims in excess of 3
104	280	204	140	Multiple dependent claim, if not paid
109	84	209	42	**Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) $ 370.00

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for *ex parte* reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	920	217	460	Extension for reply withing third month	
118	1,440	218	720	Extension for reply within fourth month	
128	1,960	228	980	Extension for reply within fifth month	
119	320	219	160	Notice of Appeal	
120	320	220	160	Filing of Appeal	
121	280	221	140	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,280	241	640	Petition to revive - unintentional	
142	1,280	242	640	Utility issue fee (or reissue)	
143	460	243	230	Design issue fee	
144	620	244	310	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Processing fee under 37 CFR 1.17(q)	
126	180	126	180	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	740	246	370	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	740	249	370	For each additional invention to be examined (37 CFR § 1.129(b))	
179	740	279	370	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other Fee (specify) _____ ($)

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) ($)

Richard Arrett, Reg. No. 43,153	Telephone 952-563-3000
Signature	Date 04/19/2002

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APPLICATION DATA SHEET

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AN APPARATUS AND A METHOD FOR THE CHEMICAL-MECHANICAL POLISHING OF THE SURFACE OF CIRCULAR FLAT WORKPIECES, IN PARTICULAR SEMI-CONDUCTOR WAFERS

CROSS REFERENCE TO RELATED APPLICATIONS

Not Applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

Not Applicable.

BACKGROUND OF THE INVENTION

After each coating of a semi-conductor wafer, e.g. with an oxide layer, a tungsten layer or other metal layers, a processing has to take place in order to achieve planar surfaces. Otherwise, problems may occur with lithographic processes in form of focus failures of the UV stepper or in form of damages of the conductor paths. A common method in the semi-conductor industry for the planarization uses the so-called CMP process. This is a chemical-mechanical treatment by means of the fluid (slurry), whereby the chemically reactive part of the slurry has the objective to convert the material into a polishable condition. The slurry includes an abrasive in the form of colloidal abrasive small particles.

From the DE 197 19 503 A1 an apparatus for the chemical-mechanical polishing of surfaces has become known. It includes two polishing stations with vertically movable vacuum chucks for a semi-conductor wafer. The polishing stations have polishing tables which can be rotated about a vertical axis. The vacuum chucks are guided along two parallel horizontally extending guides. By this, two wafers can be polished by a polishing table contemporarily. At least one transfer means for the wafers is provided. Furthermore, on opposing sides of the guides loading and

unloading means for the wafers are provided which can be aligned with the vacuum chucks. The transfer means normally are formed by a robot.

During the transportation and the processing the wafers are held by a vacuum chuck or a carrier. This has the task to transfer a homogenous pressure field or different pressure profiles onto the back side of the workpiece. The so-called sharp surface, i.e. the surface which is provided with circuits is facing the polishing table. Usually, the chuck is retained and moved by a corresponding actuating means which rotates the carrier about a vertical axis and moves it along linearly in vertical and horizontal direction.

The throughput through a CMP apparatus is mainly dependent upon the number of polishing stations. On the other side, the processing times for the planarization are relatively short (typically 90 seconds). Due to the short processing times bottlenecks may occur between the individual sections and limit the throughput.

It is an object of the invention to provide an apparatus for the chemical-mechanical polishing of workpieces, in particular of semiconductor wafers, whereby the complete time of the workpieces within the apparatus can be reduced.

BRIEF SUMMARY OF THE INVENTION

In the invention the loading and unloading station includes a carrier which is supported for rotation about a vertical axis and which is rotated by a rotary driving means. The rotatable carrier has at least two horizontal loading surfaces exposed upwardly. In the apparatus according to the invention further at least two polishing stations are associated with a circumference of the rotatable carrier. Two polishing stations preferably are located on diametrically opposed sides of the carrier. A third polishing station can be provided which has an offset with respect to the first polishing stations about an angle of 90°. Two transfer means are diametrically opposed to the last-men-

tioned polishing station. The transfer means is to load and unload the workpieces to and from the loading surfaces.

The CMP processes can be carried out by two or more steps, whereby the workpieces are planarized in different polishing stations. By using different chemical substances and polishing cloths in the different polishing stations, different materials, as for example tungsten, copper or titanium nitrite can be worked under optimized conditions. It is important to minimize the transportation times of the workpieces between the polishing stations as the chemical components of the first step may quickly etch the workpiece. In the apparatus according to the invention, a fast transportation from one polishing station to another can take place. By a quick exchange of the workpieces between the polishing stations, the throughput can be increased and the secondary times can be reduced. By the described configuration of the loading and unloading station according to the invention two or more polishing stations can be interconnected so that a fast exchange between the stations can be achieved. Also with a one step process the throughput time can be reduced since the workpieces can be treated during their transport on the loading surface, e.g. a chemical pretreatment can take place and/or a rinsing or cleaning after the polishing step.

In the present CMP process technology it is usual to clean the workpiece after the first polishing step in order to minimize the described disadvantageous effects or to eliminate these effects. In the already discussed publication DE 197 19 503 or US 6 050 885 it has become known to provide a stationary cleaning means. According to the invention, a cleaning means can be associated with the carrier so that during the transport of the workpiece on the carrier a cleaning can take place. As a consequence, undesired etchings on the workpiece can be effectively prevented by cleaning the workpieces during transportation. Additionally, the so-called

cross contamination between the polishing stations in a two step process can be eliminated.

The positioning of the workpieces on the loading surfaces by means of the transfer means normally is such that the workpieces are centered prior to being picked up by a chuck. Therefore, the loading surfaces of the apparatus according to the invention are associated with center means which cooperate with the circumference of the workpiece on the loading surface in order to align the workpiece to a predetermined vertical axis. The vertical axis of the chuck can be also aligned with this axis so that a lowering of the carrier onto the workpiece on the loading surface the chuck can pick up the workpiece in a centered manner.

The chuck for the transport of the workpieces and the cooperation with the polishing tables in the polishing station can be formed in a usual way. Preferably, the workpieces are held by vacuum. For the removing of the workpieces from the chuck an air pressure pulse can be generated after switching off of the vacuum. The movement of the chucks along vertical and horizontal axes has already become known and can be carried out as disclosed by US 6 050 885.

From the mentioned publication, it is also known to provide a linear guide for the chucks, with two chucks being provided for each polishing table. The chucks can be moved along the guide independent from each other. For this case, it is of advantage if the carrier has four loading surfaces, with each two loading surfaces having an axis which is in a plane parallel to the guides if the carrier has a corresponding rotary position. By this, per chuck one loading surface can be provided whereby the throughput of the workpieces upon polishing can be considerably increased, in particular in connection with a two or multiple step planarization process. The positioning of the four loading surfaces preferably takes place in steps of 90° or multitude of 90°.

A cleaning means is associated with the carrier. For this, the carrier can include a central elevation which per loading surface positions a nozzle which is connected to a fluid source. By the nozzle cleaning liquid can be sprayed onto the processed surface of the workpiece. The nozzle can also serve to wet the surface of the workpiece by a suitable liquid. In such an elevation also a number of detectors can be mounted which detect whether a workpiece is on a loading surface.

It is necessary to center the workpieces on the loading surfaces so that they can be picked up by a chuck in a centralized manner. As to this, different known structures can be used. According to an embodiment of the invention, a plurality of centering cams are provided which are located on a circle and which have support surfaces which accommodate a marginal portion of the workpiece. The centering cams further include radially adjustable stop surfaces which may engage the circumference of the workpiece in order to align the workpiece with respect to a predetermined vertical axis. To this purpose, the stop surfaces are synchronously actuated.

The loading surfaces can have a concave shape so that the space between an accommodated workpiece and the loading surfaces can serve as cleaning chamber. It is further possible to drain liquid from this cleaning chamber to one or more bores in the loading surface. Furthermore, a nozzle can be arranged in the loading surface for the supply of cleaning fluid to the described chamber between workpiece and loading surface. Finally, by means of such measures the contact surface of the chuck can be cleaned if it is lowered onto the loading surface.

With the invention a multi function apparatus is created by which through a rotary movement the individual polishing stations and the transfer means could be interconnected in order to decrease the transportation times as short as possible. Furthermore, by means of the multi function apparatus

the throughput can be increased, in particular in a two step or multiple step process, wherein different materials as for example tungsten, copper or titanium nitrite is to be processed with different chemical substances and polishing cloths in different polishing stations. By the integration of suitable rinsing and cleaning means, it is possible to avoid etching and chemical reactions which can occur by remainders on the workpieces. Furthermore, the multi function apparatus according to the invention prevents the so-called cross contamination, i.e. the transportation of different materials and chemical components between the polishing stations. Furthermore, the rinsing and cleaning means can be used for a chemical pretreatment of the workpieces in order to prepare the workpieces for the second and third polishing step. Since the cleaning, the pretreatment and the like takes place during the transportation, the throughput speed is not affected.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

In the following, embodiment examples of the invention are described in more detail along accompanying drawings, wherein

Fig. 1 shows diagrammatically the processing of a semi-conductor wafer with a polishing table.

Fig. 2 shows the view on a diagrammatically depicted apparatus according to the invention.

Fig. 3 shows a cross section through the carrier and the loading and unloading station of Fig. 2.

Fig. 4 shows the view onto the loading and unloading station of Fig. 2.

Figs. 5a to 5o show diagrammatically the procedure of a two step polishing process according to the method of the invention.

DETAILED DESCRIPTION OF THE INVENTION

While this invention may be embodied in many different forms, there are described in detail herein a specific preferred embodiment of the invention. This description is an exemplification of the principles of the invention and is not intended to limit the invention to the particular embodiment illustrated.

Fig. 1 shows diagrammatically the known structure of a polishing station, e.g. for a semi-conductor wafer. A polishing unit 12 is supported for linear movement along a horizontal linear guide 10 and is moved along the guide by a not shown driving means. This is indicated by double arrow S_1. The upper portion 14 which is guided by guide 10 supports a spindle 16 which can be rotatably driven by a not shown motor. The spindle is also vertically movable. A chuck 18 is mounted to the lower end of the spindle for the holding and transportation of a semi-conductor wafer not shown. The chuck can be rotatably driven by spindle 16, i.e. with speed n1. A rotatable driven polishing table 20 is arranged below the chuck 18 as is usually used for the planarization of wafers. The polishing disk or table is rotated with the revolution n2. On the polishing cloth of the polishing table 20 a slurry is supplied by a device 22, e.g. with the amounts of $\alpha 1$ and $\alpha 2$. By means of a not shown mechanism for the elevation of spindle 16 a pressure b1 can be exerted in order to press the wafer with a predetermined pressure against the polishing table 10.

A not shown dressing mechanism 24 includes a dressing disk 26 which is rotatably supported by an arm 28 and is driven by the revolution n3. The force by which the dressing disk is pressed is designated with F_2.

In the illustration of Fig. 2, two polishing stations 30, 31 are provided which resemble that of Fig. 1, two polishing units 12 being associated with each polishing station which are guided by linear guides 10a, 10b. The linear

guides 10a, 10b are lying on an axis. The structure of the polishing units of Fig. 2 corresponds to that of Fig. 1. The arrangement of the polishing units on the guides 10a, 10b corresponds to that described in US 6 050 885.

A circular carrier 34 is located between the polishing stations 30, 31 and supported for rotation about a central vertical axis. The rotary driving means are not shown. The guides 10a, 10b are extended right and left and extend over the carrier 34 approximately to the center thereof. The centers of the polishing tables 20a, 20b and of the carrier 34 are on a common axis which is parallel to the guides 10a, 10b.

Two loading and unloading stations 36 are arranged on the carrier on opposite sides of the axis which will be subsequently described in more detail. Their centers are positioned on a circle concentric to the rotary axis of carrier 34. Each of the four loading and unloading stations 36 is in a position to accommodate a wafer in a centered manner. The loading and unloading of these stations 36 take place by a diagrammatically illustrated robot 38.

In the rotary position shown in Fig. 2, the polishing units 12 can be aligned with two unloading and loading stations 36 in order to accommodate a wafer or to have a wafer removed. It is understood that a third polishing station can be provided. It is then located at the circumference of carrier 34 on the opposite side of robot 38.

The structure of the loading and unloading stations is more clearly seen in Figs. 3 and 4 which are to be described hereinafter.

A stationary frame 40 has an opening wherein the carrier 34 is supported for rotation about a vertical axis. It comprises a plurality of parts. A circular plate 42 is connected to a wheel 44 for rotation therewith, the wheel being driven about a vertical axis through a gear 46 and a driving motor 48. Plate 42 rotates with wheel 44. A trunnion-shaped holder 50 is mounted to plate 42. The holders 50 support cap-shaped elements 52. This support is axially resilient in axial direction by means of a spring 51. The

upper side of the elements 52 form a loading surface 54 for wafers 56 which can be placed on the loading surfaces. Four centering cams 58 are positioned at the circumference on the loading surface 54 in a circumferentially spaced manner. The centering cams include a support surface not shown in detail for the wafers 56. Thereby, the wafers 58 are only supported on four spots at a marginal portion thereof (in Fig. 3 only two centering cams 58 can be seen). In Fig. 4 four centering cams 58 can be recognized. The radially movable centering cams have a stop surface which is radially moved by an actuation mechanism 60. This mechanism includes a motor 61 which effects on four rods 65 through a gear 63 in order to move the cams 58. These are formed as levers which are pivoted by the rods 65. The stop surfaces are also not shown. By means of the stop surfaces or the centering cams 58, respectively, a wafer disk accommodated can be centered with respect to a predetermined axis, e.g. the center axis of element 52.

The top wall of element 52 includes a throughbore 62 which is provided with a connection fitting 64 for a fluid. Through this fitting fluid can be conveyed to the lower side of the wafer accommodated. Furthermore, bores can be provided to remove liquid from the loading surface.

Spaced from plate 42 a plate 66 can be fixedly attached to plate 42 which in the area of element 52 has openings 68. In the center, plate 64 has an elevation 70 which has an inner hollow space, the elevation being aligned with an axial passage 72 from wheel 44 to plate 42. In the slightly oblique wall of elevation 70 a number of nozzles is arranged in the upper portion which is shown at 74. Each loading and unloading station 36 is associated with a nozzle 74 which is directed to a loading surface. A conduit connected to a fluid source is connected with nozzle 74 in order to spray a fluid onto the upper side of a wafer accommodated. Also a radiation source 78 is provided for each loading and unloading station 36 which is directed to the loading

surfaces 54 and cooperates with a receiver 79 which indicates whether a wafer 56 is accommodated.

The carrier 34 is encircled by a sealing ring 80 of frame 40, a labyrinth sealing 82 being located between ring 80 and plate 66. A dripping tub (not shown) is below ring 80. Each cap-shaped element 52 is also provided with a dripping tub 82 in order to accommodate liquid or slurry, respectively, and to drain it to the tub for the complete system.

According to Fig. 2, the robot 38 can load wafers on two associated loading and unloading stations or remove wafers therefrom. It is also conceivable to bring the carrier into a rotary position wherein only one station 36 can be served by the robot 38. In the rotary position according to Fig. 2 the polishing unit then can only pick up one wafer from the loading and unloading means or place one wafer thereon. If the left polishing station is for the first processing while the next processing takes place in the right polishing station, the carrier 34 carries out a rotation about 180° after the placement of wafers on the associated loading and unloading stations so that the associated polishing unit can pick up the wafer and transport it to the associated half of polishing table 20b. During the rotation of carrier 34 the surface of the wafers can be cleaned, e.g. by means of nozzle 74 in order to remove remainders of a treating substance and to avoid an undesired etching. Thus, the loading and unloading station 36 in conjunction with carrier 34 is not only a means to center accommodated wafers to allow a centered pick up by chuck 18, rather, also a transportation means between two or more polishing stations and a cleaning station as well for the cleaning process to wafers prior to the further transport to the next polishing station or prior to the removal by robot 38.

The loading surfaces 54 can be shaped concavely so that a chamber is formed at the back side of the wafer 56 as already described. The loading surface can be provided with bores for the drainage of fluid or for the supply

of fluid. In this way, also the back side of the accommodated wafers 56 can be cleaned. Furthermore, the contact surface of the chuck can be cleaned if it is lowered onto the loading surface.

It is understood that the described driving means for individual parts of the polishing system and the cooperation of these driving means can be controlled by a suitable not shown control device. Such control devices are generally known.

In the following, a two step polishing process is explained along Figures 5a to 5o. A rotating carrier is located between two polishing disks POT1 and POT2. The carrier has four loading surfaces WLT1 to WLT4. An arrangement can be used as shown in Figs. 2 to 4. The transfer means 38 is not shown and also not the chuck (polishing units 18) by which the wafers can be transported and held against the polishing disk POT1 and POT2. In case of Fig. 5, the transfer means or robot is on side A of the shown arrangement. The opposing side is designated with B. For the sake of comprehensiveness in Figs. 5a to 5o a radial line is shown. In Fig. 5a this line indicates the zero position of the carrier. In the other Figures, the position is indicated with 90° or a multitude of 90°.

In Fig. 5a, the loading surfaces WLT1 and WLT2 are loaded with workpieces W1 and W2. This takes place with the not shown transfer means and the loading can take place contemporarily or step-by-step. Subsequently, the carrier according to Fig. 5b is rotated about –90°, whereby the workpieces W1 and W2 are facing the first polishing disk POT1. In this position, the wafers can be picked up by the chucks and moved above the polishing disk POT1. This can be seen in Fig. 5c. Now, in this first polishing station the processing of the wafers W1 and W2 can take place.

As soon as wafers W1 and W2 are removed from the carrier, two further wafers W3 and W4 are placed on the loading surfaces WLT1 and WLT4. Afterwards, the carrier is rotated back about 90° into the zero

position as can be seen in Fig. 5e. In this position, the wafers W1 and W2 can be brought back to the loading surfaces WLT2 and WLT3 after finishing of the polishing process. This is shown in Fig. 5f. Thereafter, the carrier is rotated about 180° as can be seen in Fig. 5g. In this position, the chucks which are associated with the polishing disk POT2 can transport the wafers W1 and W2 to the second polishing disk POT2 as shown in Fig. 5h. Contemporarily, the wafers W3 and W4 can be moved to polishing disk POT1 by the associated chucks.

During processing of the wafers W1 to W4 by the polishing disk POT1 and POT2, the loading surfaces WLT1 to WLT4 are empty. So, they can be loaded with further wafers W5 and W6 as shown in Fig. 5j. According to Fig. 5k, the carrier is rotated in clockwise direction so that wafers W5 and W6 are aligned to polishing disk POT1 while the empty loading surfaces WLT2 and WLT3 as associated with polishing disk POT2. In this position, the finished wafers W1 and W2 can be placed on the associated loading surfaces as shown in Fig. 5l. Thereafter, the carrier is rotated about further 90° so that the wafers W1 and W2 can be removed (as shown in Figs. 5m and n). Thereafter the carrier is again rotated about 90° so that the wafers W5 and W6 are aligned with polishing disk POT2. Thus, the wafers W3 and W4 processed in the first station can be placed on the carrier. Thereafter, the further processing takes place as described in connection with Fig. 5f and the following.

During the presence of the wafers W1 to W6 on the loading surfaces they can be pretreated, rinsed and cleaned as already described above. By these process steps the complete throughput time in a two step polishing process for the wafers is not extended.

What we claim is:

1. An apparatus for the chemical-mechanical polishing of surfaces of circular flat workpieces, in particular semi-conductor wafers, comprising

   - a loading and unloading station for the workpieces which includes:
   - a carrier (34) which is supported for rotation about a vertical axis and is driven by a rotary driving means (48) into a predetermined rotary position,
   - at least two horizontal loading surfaces (54) on the carrier means (34) facing upwardly, further comprising
   - a transfer means (38) adapted to place workpieces on the loading surfaces (54) and to remove the workpieces therefrom,
   - at least two polishing tables (20a, 20b) in corresponding polishing stations (30, 31) which are located at the circumference of the carrier means (34),
   - at least one chuck (18) for the workpieces (56) for each polishing station, the chuck being adapted to be moved along a vertical and a horizontal axis by moving means to align the chuck with a loading surface (54), to hold and discharge a workpiece (56) and for the transfer of the workpiece as well to the associated polishing station (30, 31) and away therefrom and for the cooperation with the polishing table (20a, 20b) of the associated polishing station (30, 31) and
   - control means for a rotary driving means (48) and the moving means.

2. The apparatus of claim 1, wherein the carrier means (34) include centering means (58, 60) for each loading surface (54), the centering means including centering elements which are actuated by actuation means and

engage the circumference of a workpiece (56) on the loading surface (54) in order to radially position the workpiece (56) in alignment with a predetermined vertical axis.

3. The apparatus of claim 1, wherein cleaning means are associated with the carrier means for the cleaning and hydrosation and/or the wetting of the surface of the workpiece (56) on the loading surfaces (54).

4. The apparatus of claim 1, wherein four loading surfaces (54) are provided on the carrier means (34).

5. The apparatus of claim 1, wherein four loading surfaces (54) are provided on the carrier means, linear guiding means (10a, 10b) being associated with each polishing station (30, 31) for two independently guided chucks (18) and the loading surfaces (54) are located such that in a predetermined rotary position of the carrier means the vertical axis of a loading surface (54) and of the chuck (18) lie in a common vertical plane which extends parallel to the guiding means (10a, 10b).

6. The apparatus of claim 1, wherein the carrier means (54) has a central elevation (70), wherein nozzles (74) are located which are directed to the loading surfaces (54) and are connected with a fluid source.

7. The apparatus of claim 6, wherein detectors (78) are located in the elevation (70) in order to determine whether a workpiece (56) is positioned on a loading surface (54).

8. The apparatus of claim 1, wherein the carrier means (34) is surrounded by a side wall of a dripping tub which extends below the carrier means (34).

9. The apparatus of claim 8, wherein a dripping tub (82a) is associated with each loading surface (54) and has an outlet towards the first dripping tub.

10. The apparatus of claim 1, wherein for each loading surface the centering means has centering cams (58) arranged on a circle and being movable in radial direction, the centering cams (58) including support surfaces for the marginal portions of a workpiece (56) and stop surfaces which upon a radial displacement of the centering cams engage the circumference of a workpiece (56), with the stop surfaces being moved synchronously by actuating means (60) in order to align the axis of the workpiece (56) with a predetermined vertical axis.

11. The apparatus of claim 1, wherein the loading surfaces (54) are concave and include bores for the drainage of a liquid which is collected on the loading surface (54) and/or comprises at least one nozzle (64) for the cleaning of the back side of the workpiece (56) on the loading surface (54).

12. The apparatus of claim 1, wherein the loading surfaces (56) are provided on the top side of a separate cap-shaped element (52) which is supported on a trunnion-shaped upright support portion (50) of the carrier means (34).

13. A method for the chemical-mechanical polishing of the surface of semiconductor wafers by means of two polishing stations, each having a

polishing table, two chuck for each polishing station which independently from each other can be moved vertically and horizontally, four loading surfaces having a center lying on a circle which loading surfaces can be rotated about a vertical axis, the loading surfaces being located between the polishing stations such that in predetermined common rotary positions which are spaced about an angle of 90° or a multitude of 90°, two loading surfaces are aligned with the linear transport path of two chucks belonging to a polishing station, in a predetermined rotary position the loading surfaces being adapted to be loaded with a loading and unloading means with a workpiece or to remove a workpiece from the loading surfaces, comprising the following method steps:

a) after loading two loading surfaces with a first and a second workpiece the loading surface are rotated about 90°, whereby the workpieces are aligned with the first polishing station and are moved from the chucks to the first polishing station to the polishing tables in order to carry out a first polishing step

b) after removal of the first and second workpiece by the chucks, a third and a fourth workpiece are placed on the associated loading surfaces and by rotation of the loading surfaces about 90° are aligned to the second polishing station, whereafter the first and second workpiece are removed from the first polishing station by the chucks and are placed on the association free loading surfaces

c) after rotation of the loading surfaces about 180° the first and the second workpiece are carried to the second polishing station and the third and fourth workpiece are carried to the first polishing station by the associated chucks

d) after finishing of the polishing process the workpieces are placed on the association loading surfaces and the third and fourth workpiece

are aligned with the second polishing station and the first and second workpiece are removed by the loading and unloading means so that thereafter a loading with a fifth and sixth workpiece can take place.

14. The method of claim 13, wherein after step c) a fifth and sixth workpiece is placed on the associated loading surfaces and are aligned to the first polishing station after rotation about 90°, whereafter the first and second workpiece is removed from the second polishing station and placed on the associated loading surfaces and after rotation of the loading surfaces about 90° the first and second workpieces are removed and by rotation about further 90° the free loading surfaces are aligned to the first polishing station for the receipt of the third and the fourth workpiece and to the subsequent transport to the second polishing station and for the transport of the fifth and sixth workpiece to the first polishing station.

15. The method of claim 13, wherein the wafer is chemically treated, rinsed and/or cleaned.

AN APPARATUS AND A METHOD FOR THE CHEMICAL-MECHANICAL POLISHING OF THE SURFACE OF CIRCULAR FLAT WORKPIECES, IN PARTICULAR SEMI-CONDUCTOR WAFERS

ABSTRACT OF THE DISCLOSURE

An apparatus for the chemical-mechanical polishing of surfaces of circular flat workpieces, in particular semi-conductor wafers, comprising a loading and unloading station for the workpieces which includes a carrier which is supported for rotation about a vertical axis and is driven by a rotary driving means into a predetermined rotary position, at least two horizontal loading surfaces on the carrier means facing upwardly. With a transfer means the workpieces can be placed on the loading surfaces or removed therefrom. At least two polishing tables in corresponding polishing stations are provided which are located at the circumference of the carrier means and at least two chucks for the workpieces, the chucks being adapted to be moved along a vertical and a horizontal axis by moving means to align the chuck with a loading surface, to hold and discharge a workpiece and for the transfer of the workpiece as well to the associated polishing station and away therefrom and for the cooperation with the polishing table of the associated polishing station and a control means for the rotary driving means, the actuation means and the moving means.

PATENT/DESIGN PATENT

DECLARATION

As a below-named inventor, I(we) hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name;

I verily believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

AN APPARATUS AND A METHOD FOR THE CHEMICAL-MECHANICAL POLISHING OF THE SURFACE OF CIRCULAR FLAT WORKPIECES, IN PARTICULAR SEMI-CONDUCTOR WAFERS

(Insert invention title)

the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to in the declaration.

I acknowledge the duty to disclose all information which is known to be material to patentability of this application in accordance with Title 37, Code of Federal Regulations § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119, of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

(List prior foreign applications)

COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 USC 119
~~Germany~~			[ ] YES NO [ ]
			[ ] YES NO [ ]
			[ ] YES NO [ ]

I hereby declare that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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(Attach additional sheets for third and subsequent inventors)

PATENT/DESIGN PATENT

DECLARATION

Additional Sheet

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UTILITY/DESIGN PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Ulrich Ising, Marc Reichmann and Thomas Keller

Title: AN APPARATUS AND A METHOD FOR THE CHEMICAL-MECHANICAL POLISHING OF THE SURFACE OF CIRCULAR FLAT WORKPIECES, IN PARTICULAR SEMI-CONDUCTOR WAFERS
Filed:

Ser. No.

Docket No.: H01.2-10395

Commissioner for Patents
Washington, DC 20231

POWER OF ATTORNEY FROM ASSIGNEE

As Assignee of record of the entire interest of the above identified patent application, hereby appoints the following attorneys to insert the docket no., filing date and application number of said application above when known; to prosecute this application and any application claiming priority therefrom; to execute any terminal disclaimers on behalf of assignee; and to transact all business of the Patent and Trademark Office connected therewith:

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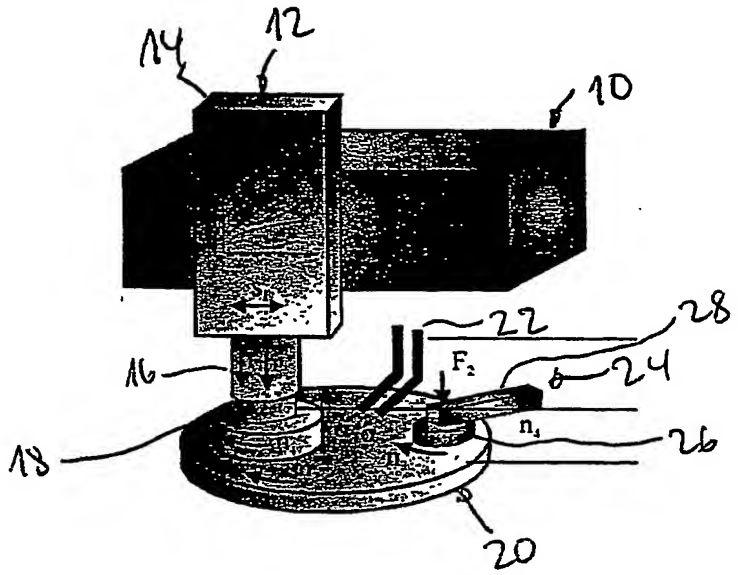
all of **Vidas, Arrett & Steinkraus, P.A.**, Suite 2000, 6109 Blue Circle Drive, Minnetonka, Minnesota 55343-9185, (952) 563-3000 to prosecute the application to issuance and to transact all business in the Patent and Trademark Office in connection therewith.

Dated: 28.3. 2002

F. Gitmans

by: Dr. Frank Gitmans
its: Managing Director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28
16
F_2
24
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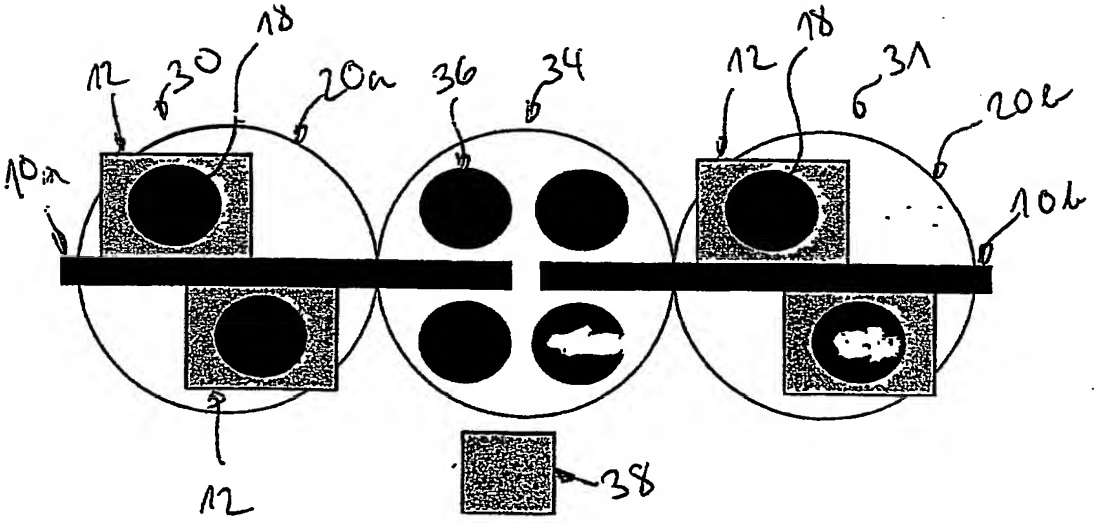
n_1
26
n_2
20

FIG 1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36
34
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18
31
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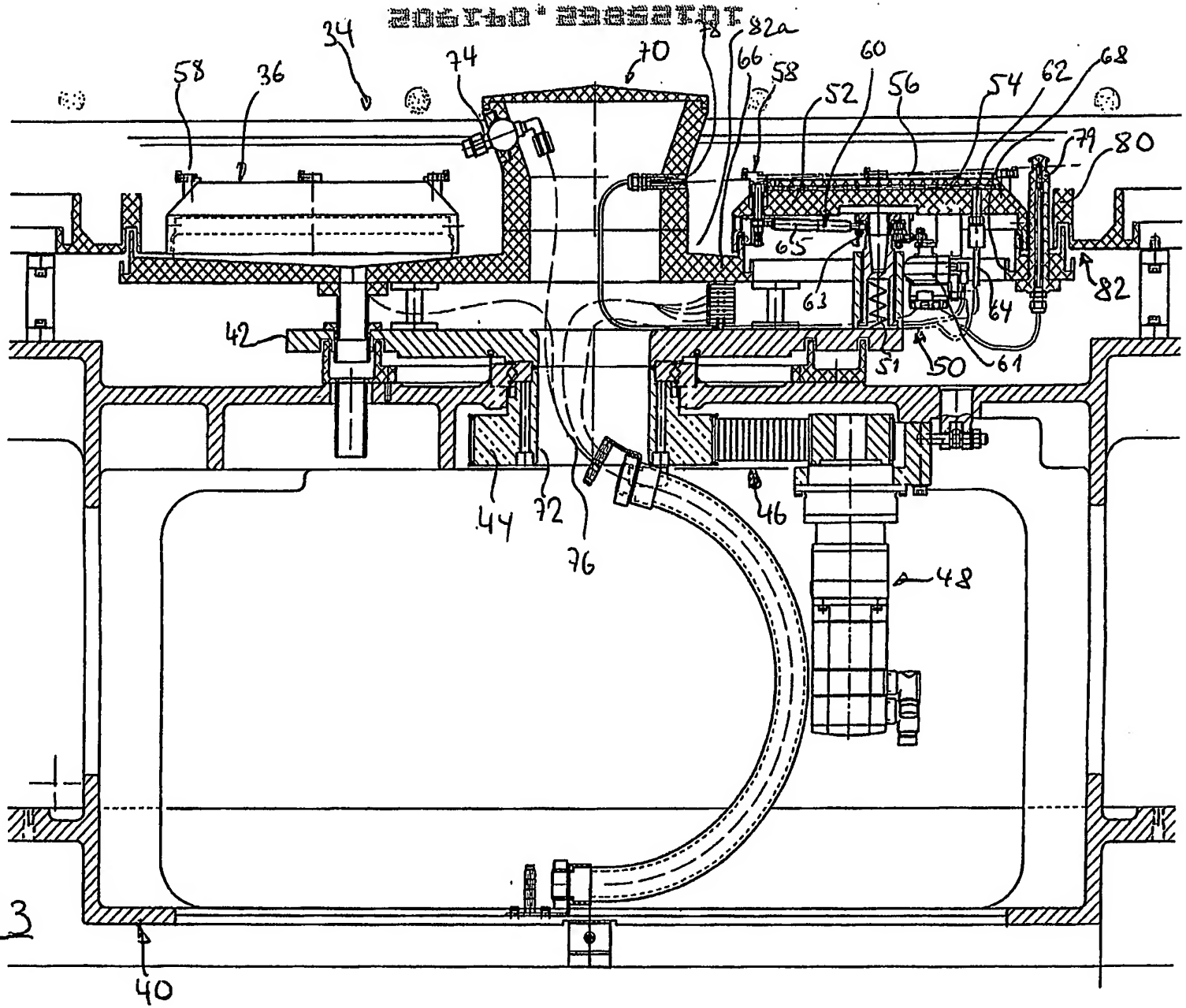
10a
10b
12
38

FIG 2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40

FIG 3

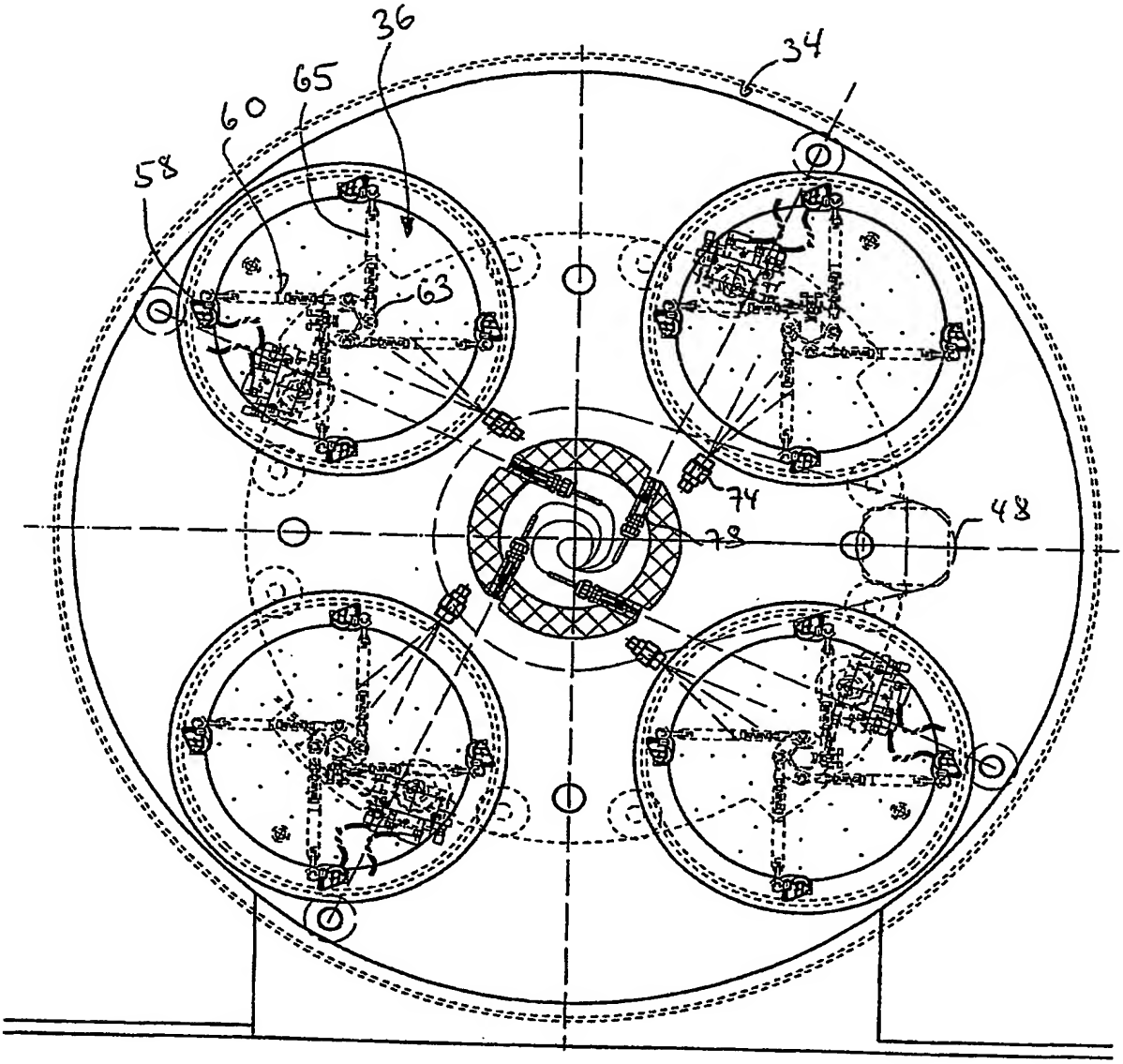
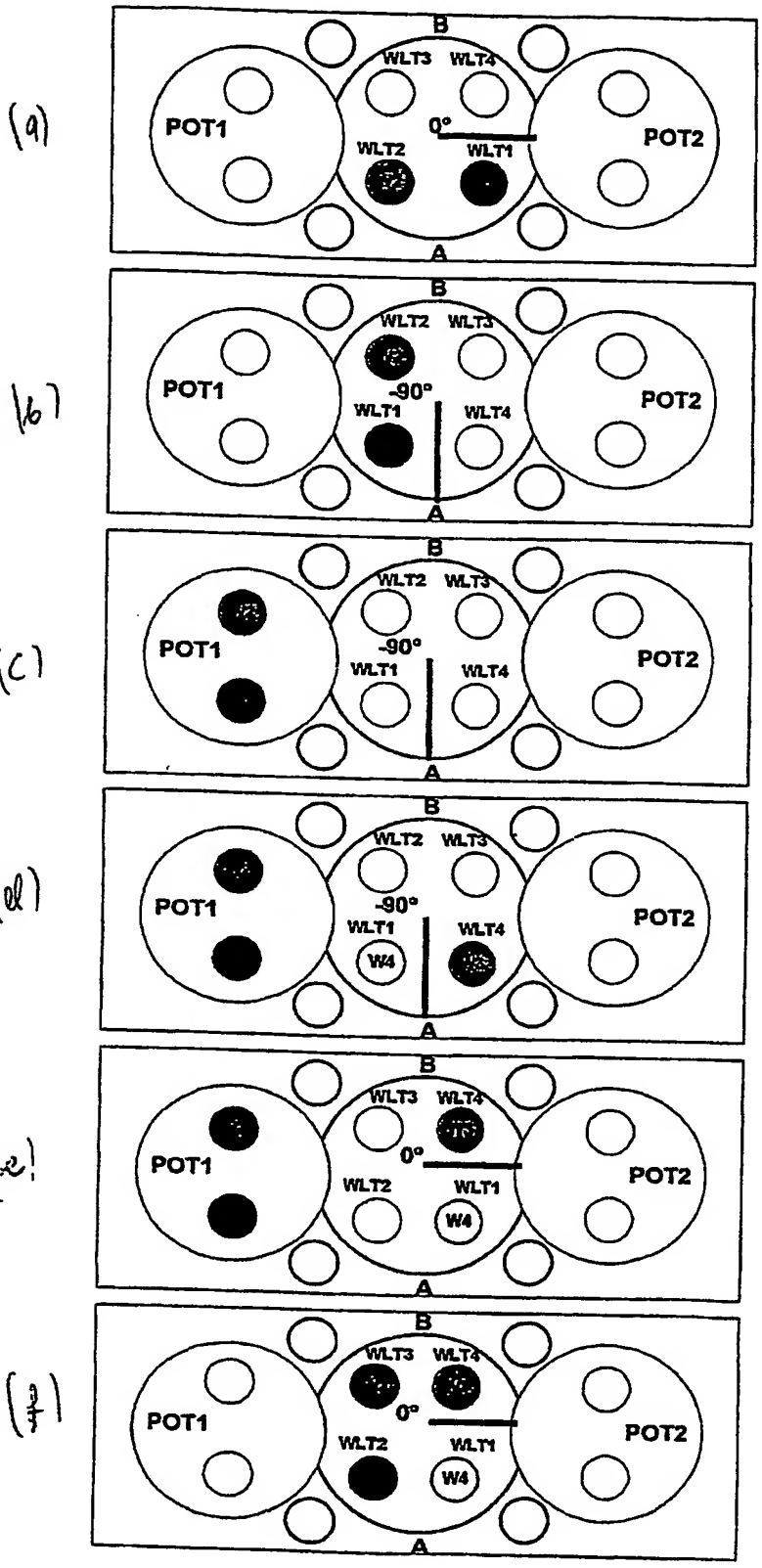


Fig 4

Fig 5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POT2
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A
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WLT3
POT1
-90°
WLT1
WLT4
POT2
A
(c)
B
WLT2
WLT3
POT1
-90°
WLT1
WLT4
POT2
A
(d)
B
WLT2
WLT3
POT1
-90°
WLT1
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W4
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WLT1
W4
POT2
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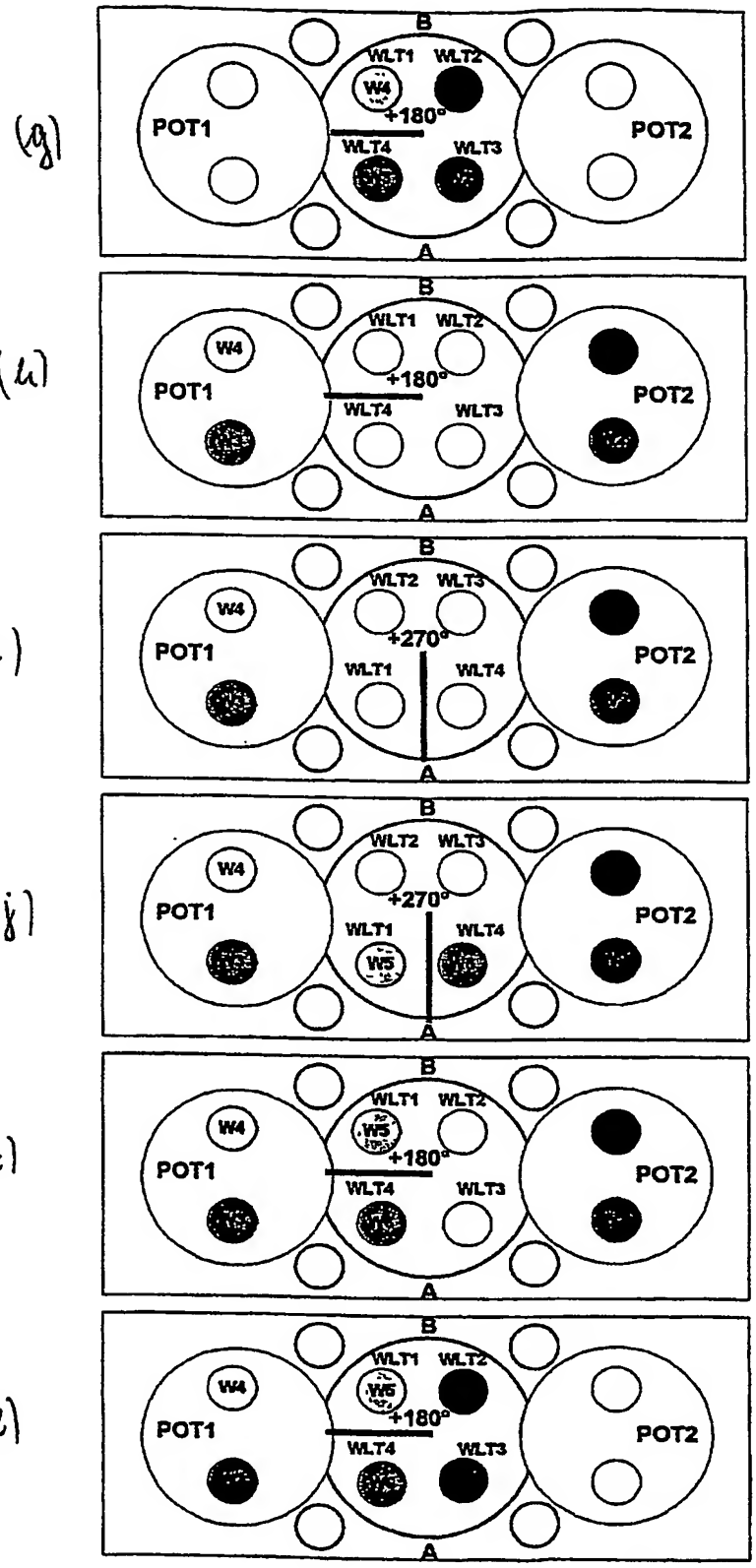
W4
POT2
A

Fig 5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WLT2
W4
POT1
+180°
POT2
WLT4
WLT3
A
(i)
B
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WLT3
W4
+270°
POT1
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W5
W4
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POT1
POT2
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WLT3
A
(l)
B
WLT1
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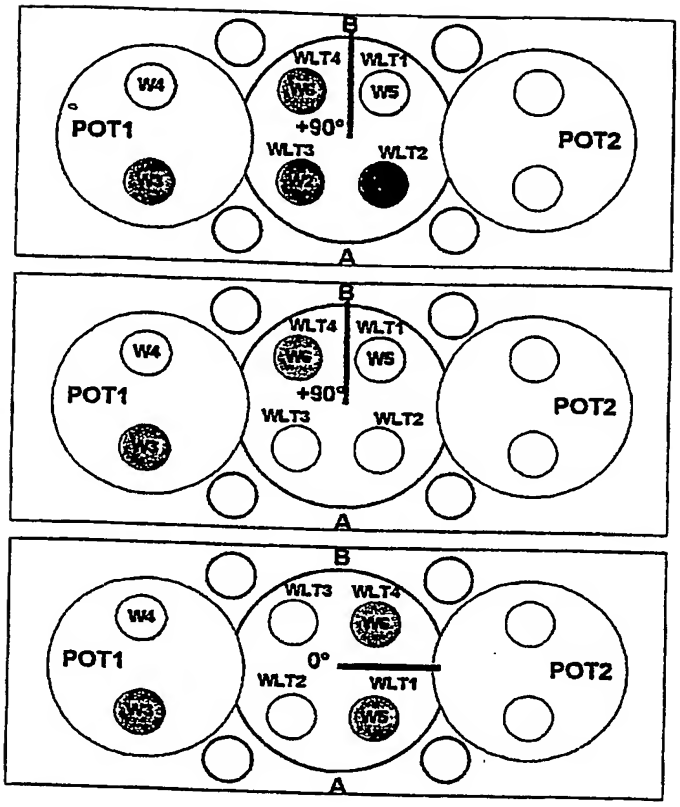
A

Fig 5

(m)

(n)

(o)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W4
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W5
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+90°
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W6
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0°
POT2
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WLT1
W3
W5
A